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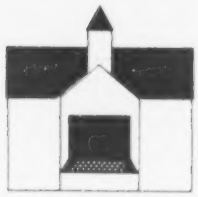
Instructional Uses of School Computers



Reports from the 1985 National Survey Issue No. 1, June 1986

Center for Social Organization of Schools The Johns Hopkins University

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Schools are not known for being quick to change. Over a two year span, you would not expect to find many changes in school instructional practices. But, think about how schools have invested in computers over the past few years.

Between Spring 1983 and Spring 1985, in U.S. elementary and secondary schools, the following changes occurred:

* The number of computers in use quadrupled from about 250,000 to over one million.
* Three-quarters of the schools which had not previously used computers began to do so.
* The proportion of elementary schools with five or more computers jumped from 7% to 54%.
* The proportion of secondary schools with 15 or more computers rose from about 10% to 56%.
* The typical computer-using secondary school went from five computers in use to 21 in high schools and to 14 in middle schools.
* The typical computer-using elementary school went from two computers in use to six.
* During the 1984-1985 school year, approximately 15 million students and 500,000 teachers used computers as part of their schools' instructional programs.

These summary statistics are calculated from data collected in the Second National Survey of Instructional Uses of School Computers, the most extensive survey on school computer use to date. The survey gathered information from more than 10,000 teachers and principals in a probability sample of over 2,300 U.S. elementary and secondary schools during the Spring of 1985. This report -- the first of six to be issued from this survey -- concentrates on basic numbers. In a typical school, how many students and how many teachers use computers? How much are the computers actually used? For what instruction are they used? Where are the schools' computers located? How much time do individual students get to use school computers?

Are Schools Now Well-Supplied With Computers?

By the Spring of 1985, almost all secondary schools and five-sixths of the elementary schools in the U.S. had begun to use computers in their instructional program (Table 1). Ninety percent of U.S. school children attended schools that had at least one computer.

GENERAL NOTES ABOUT TABLES AND FIGURES

General descriptive data is usually tabulated according to the grade span of the school, with each school in the sample assigned to the best-fitting grade span category. Six categories were used: K-6, Middle, High School, K-8, K-12, and Junior-Senior Highs. Comparisons with 1983 survey data are limited by the less detailed categories used in the analysis of the earlier survey ("elementary" included K-6 and K-8; "secondary" included all others except K-12 schools which were omitted from the 1983 analyses.) The text discusses most data presented in tabular form. However, some table data is presented without comment, and some information discussed in the text is not included in the tables.

Table 1: Percent of U.S. Schools Using Any Computers for Instruction, Using 5 or More, and 15 or More Computers by Grade Span of School, Spring, 1985.

Grade Span of School	Percent of U.S. Schools		
	Any Computers Used For Instruction	5 or More Computers	15 or More Computers
K-6 Elem.	85%	57%	12%
Middle/Jr.High	95%	85%	47%
High School	97%	92%	68%
K-8 Elem.	81%	46%	9%
K-12 School	72%	48%	11%
Jr./Sr. High	90%	82%	45%
U.S. Total	86%	63%	24%

But schools were not obtaining computers one or two at a time. They were obtaining them in fours, sixes, and fifteens. Schools had learned that they needed large numbers of computers if computers were to be more than showpieces for outside visitors. Schools, after all, are organized to provide instruction to students in groups of 20 or 30 or 40. To be functional, school resources must match the setting in which they offer instruction.

By last Spring, large investments in computer hardware over the preceding two years had brought the typical school to a ratio of one computer for roughly every 40 students (Table 2). Yet even a 40-1 ratio cannot provide most students at a school with a substantial amount of computer time.

How much computer time students should have is, of course, a complex issue. The effectiveness of computer-based instruction depends not only on software quality and hardware sophistication, but on (1) how well computer activities are integrated into other instructional activities, (2) whether there are alternative and less expensive ways that students can achieve comparable academic competencies and understanding, and (3) whether it is more important that students learn those particular things rather than other skills or competencies that might not be best learned using computers. The optimum allocation of computer time is likely to increase over time, and may vary for children of different ages, prior backgrounds, abilities, or preferred learning styles.

Table 2: Median Number of Computers and Median Student-Computer Ratio in U.S. Schools with Computers by Grade Span of School, Spring, 1985.

Grade Span of School	Median Number of Computers	Median Ratio of Students to Computers
K-6 Elem.	6	60-1
Middle/Jr.High	14	41-1
High School	21	31-1
K-8 Elem.	5	41-1
K-12 School	6	26-1
Jr./Sr. High	14	25-1
U.S. Total	8	42-1

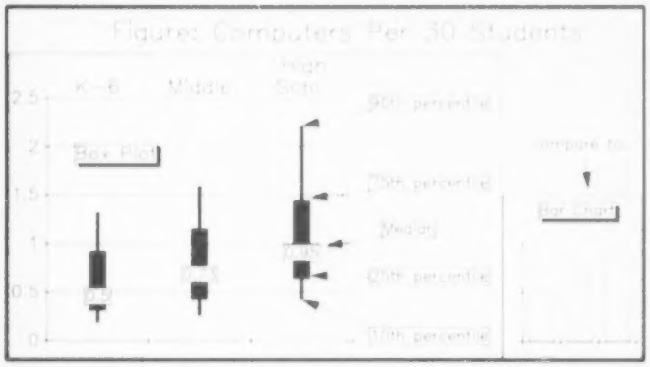
However, even today, under the right conditions, a typical high school student could profitably use computers for writing compositions, for memorizing whatever facts are truly unavoidable, for understanding relationships and concepts in mathematics and science courses, and for writing computer programs. Each of these SEPARATE uses might occupy 30 minutes to 3 hours of computer time per week. Thus, a high school student might profitably use computers for an hour or two per DAY.

Despite their increasing acquisition of computers for instruction, hardly a school in the country has the computer resources to give that much computer time to each of its students. To provide even 30 MINUTES of computer time per day to all students enrolled, a school would need to have one computer for every 12 students -- and that assumes the computers are in constant use for 6 hours per day, with no time lost to transitions, scheduling foul-ups, or other interruptions. As of Spring, 1985, such a favorable student-to-computer ratio was available at only 7% of high schools and roughly 2% of elementary and 3% of middle schools in the country. Yet, by limiting the number of students who use school computers, many schools do provide a substantial experience to at least some of their students.

How many students use school computers?

During the 1984-1985 school year, nearly half of elementary and middle school pupils and as many as one-third of U.S. high school students made some use of computers at school.

During an average week, at a typical computer-using school, more than one-quarter of the student body used computers. Students in elementary schools were more likely to have some use of computers than were students in secondary schools. For example, at a typical K-6 computer-using school, 30% of the students used computers during an average week, while at a typical high school only 21% used computers. The typical computer-using



THE "BOX PLOT"

Figures such as the one above are included at several points in this issue to provide information both about the "typical" school and the range of variation that exists on some aspect of the presence of computers in the schools, such as (in the above example) the number of computers at each school per 30 students enrolled.

The box plot has 3 elements. The number enclosed in the transparent square gives the median (number of computers per 30 students enrolled) for the group of schools indicated at the top of that column (e.g., K-6 elementary schools, for the first column). The median would be the only element appearing in a more conventional chart.

The other two elements of the box plot assume that each group of schools is ranked from "lowest" to "highest" on the measure in question (e.g., from schools with the fewest computers per 30 students to those with the greatest number). The solid black rectangle represents the middle 50% of schools (encompassing the 25th to the 75th percentiles), according to their computer-to-student ratio. The line segments extending upward and downward from this rectangle represent most of the remaining schools -- those from the 75th to the 90th percentiles and those from the 10th to the 25th percentiles.

The box plot allows one to draw a number of conclusions not possible with the basic bar chart. For example, schools at the 90th percentile have more than twice as many computers per 30 students as the median school of the same grade span. Schools at the 10th percentile have one-third to one-half as many as the median school. The top 25% of the computer-using K-6 elementary schools have roughly the same computer ratios as half the high schools do. And nearly all schools have fewer than 2 computers per classroom of students (if they were spread among all classrooms).

school provided computer opportunities to about twice as many students in 1984-85 as they did two years earlier. (In 1983, roughly 15% of the typical elementary school's student body and 11% of the typical secondary school's student body had used computers during an average week.)

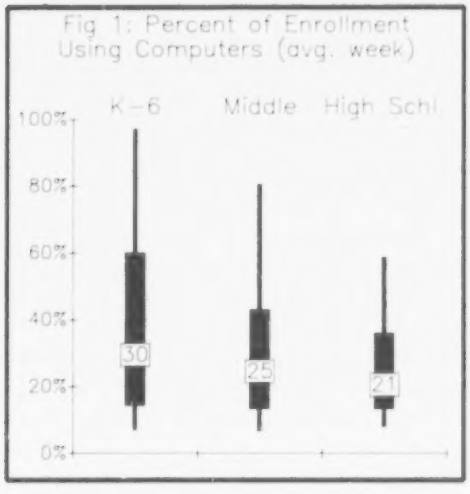
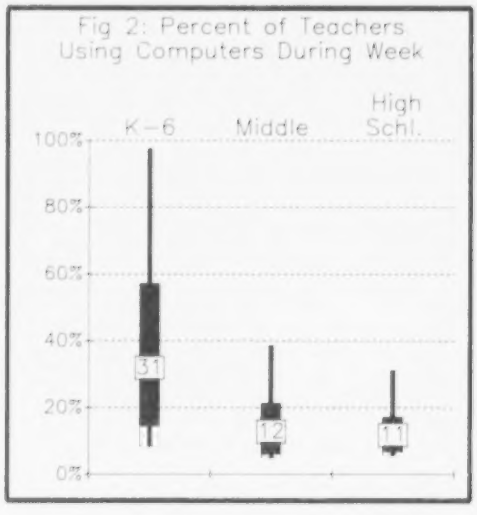


Figure 1 shows that computer-using schools varied widely in how much they spread computer experiences among their students. One-fourth of computer-using K-6 elementary schools reported that a majority of their students used computers during an average week. About 15% of high schools reported use by a majority of their students. At the other extreme, one-fourth of computer-using schools at all levels reported that fewer than one out of seven of their students used computers during an average week. The proportion of students who used computers sometime during the full school year was somewhat higher, but the differences across schools were similar to those shown in Figure 1 for one week's activity.

How many teachers use computers?

One-fourth of all U.S. teachers used computers "regularly" with students during the 1984-85 school year. A much higher proportion of elementary school teachers did so (37% in the K-6 schools) than did secondary school teachers (15%). Similarly, during an average week at the typical computer-using elementary school, 31% of the teachers used computers with students, but during that same week only 12% of the teachers at a typical secondary school used computers with students (Figure 2). However, because schools with older students tend to be larger, roughly the same NUMBER of teachers (5 per school) used computers regularly during the year at the median computer-using school at all three levels — elementary, middle, and high school.



For each school, we obtained an estimate of the number of computer-using teachers who were "expert" in each of four aspects of using computers -- "using some instructional programs," "knowing about a wide variety of programs," "using word-processing or other professional tools," and "writing computer programs." In each area, a much higher proportion of secondary school computer-using teachers were viewed as expert (Figure 3). Overall, combining these four areas of computer-related knowledge, 27% of computer-using high school teachers were viewed as experts as were 21% of computer-using middle school teachers, but only 10% of computer-using elementary (K-6) school teachers.

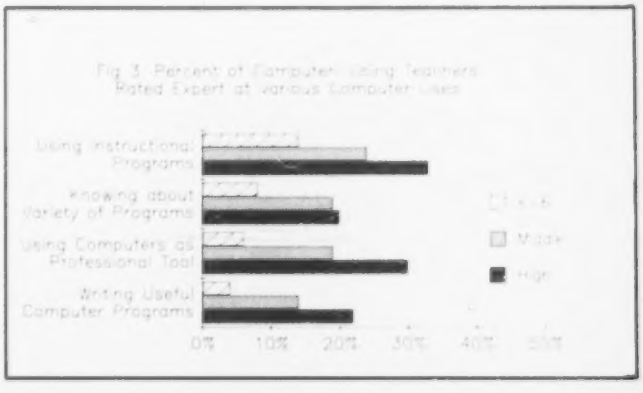


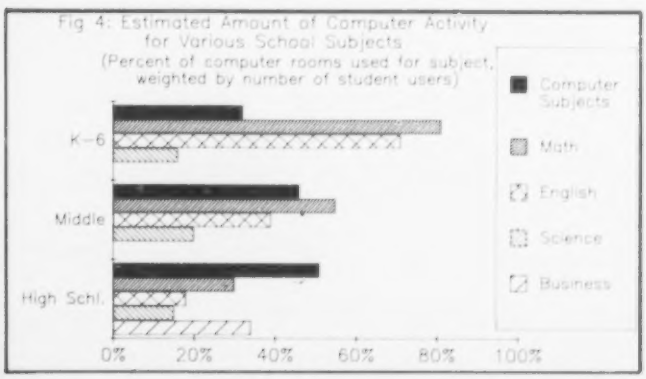
Table 3: Mean Percent of Instructional Computer Time (Global Assessment by PCUT), Spring, 1985.

Grade Span of School	Drill & Practice	Discovery Learning Problem Solving	Programming	Word Processing	Other
K-6 Elem.	56%	17%	12%	9%	6%
Middle/Jr.High	30%	15%	32%	15%	9%
High School	16%	10%	49%	20%	5%
K-8 Elem.	49%	19%	19%	6%	8%
K-12 School	39%	11%	31%	16%	3%
Jr./Sr. High	25%	12%	40%	20%	3%
U.S. Total	32%	14%	33%	15%	6%

What are the major instructional uses of school computers?

The ways students use computers differ sharply by grade level, as one would expect. More than half of the student use of computers in elementary schools involves using "drill-and-practice" and "tutorial" programs (that is, "computer-assisted instruction" or "C.A.I.") and only about 12% of their time is spent writing computer programs. In contrast, high school students spend only 16% of their computer time on computer-assisted instruction, but spend half their time programming (Table 3). Across all school levels, about one-third of student instructional time on school computers is for "C.A.I.," one-third is for programming, and one-third is for all other academic work, including "discovery learning" and word processing.

Mathematics and language arts (English and reading) are the major subjects for which computers are used in elementary schools. These two are joined by computer literacy as a third major use in middle schools. In high school, computer literacy and programming are the dominant subjects, with business education and mathematics following about equally far behind. (Figure 4 gives a rough guide to actual use in different subjects. It is a summary report of computer uses for each room in the school that has computers. Future newsletters will report more detailed data reflecting how each computer-using teacher uses computers for particular classes and subjects.)



How much computer time for a typical student computer-user?

The amount of experience that any one computer-using student had with school computers doubled between 1983 and 1985. In 1983, a typical elementary school student who used a computer during a week had about 20 minutes of computer time. By 1985, the typical elementary school student had 35 minutes of computer time. At the secondary school level, time per student user also doubled, increasing from about 45 minutes per week to roughly 90 minutes per week. The median high school student user had even more time -- an hour-and-three-quarters per week (Figure 5).

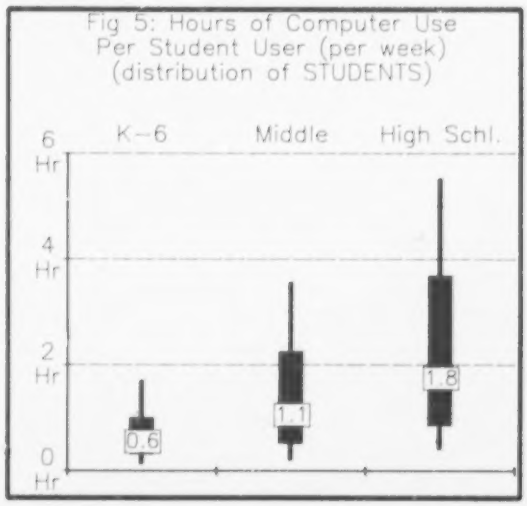
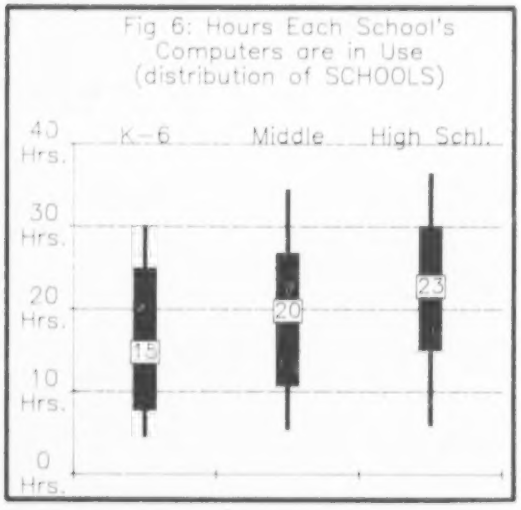


Figure 5 shows a substantial spread among computer-using students in how much computer

time they have during an average week. The 10% of computer-using students with the most computer time use the computer at least three times as much as the typical computer-using student at the same grade level. In fact, although not shown in Figure 5, the most active 10% of computer-using students at each school level --elementary, middle, and high school -- take more than one-third of all student computer time, while the most active 25% get roughly three-fifths of all student computer time.

How much use is each computer getting and which schools are using their computers more?

Students are getting more time to use computers at school for two reasons: there are more computers at each school, and each computer is used more. In 1983, schools used their computers, on average, for about 12 hours per week (11, elementary; 13, secondary). In 1985, the typical computer was used about 50% more, with the increases somewhat greater in secondary schools than in elementary schools. The typical high school used its computers for 23 hours per week (including before and after school use), the typical middle school used its computers for 20 hours per week, and the typical K-6 elementary school used its computers for 15 hours per week (Figure 6).



Schools with more computers use them more. For example, high schools with 15 or more computers use them an average (mean) of 24 hours per week while high schools with 3-5 computers use them for only 17 hours per week. Elementary schools with 15 or more computers use them for 20 hours per week, while those with only 3-5 use them for 16 hours per week.

Are computers grouped together, and does this enable classrooms of students to use them at once?

Schools with a substantial number of computers can cluster them together or scatter them throughout the school. Only if clustered together in groups of eight or 12 or 15, can a substantial fraction of any one teacher's class use computers at the same time. Most schools do keep their computers in one, two, or three locations in their building. The typical elementary and middle school keeps its computers in two rooms, and the typical high school uses three rooms for its computers.

Yet because elementary schools still have a limited number of computers, even with clustering most elementary teachers cannot use computers with all or half of their students at the same time. Only 6% of the K-6 schools have 15 or more computers in one room. In contrast, nearly half of the computer-using high schools have 15 or more computers in one room (Table 4).

Table 4: Percent of Schools with a Substantial Number of Computers in a Given Location by Grade Span of School, Spring, 1985.

Grade Span of School	Percent of Computer Using Schools With:	
	7 or More Computers In Any One Room	15 or More Computers In Any One Room
K-6 Elem.	22%	6%
Middle/Jr.High	67%	35%
High School	85%	47%
K-8 Elem.	26%	4%
K-12 School	24%	4%
Jr./Sr. High	64%	26%
U.S. Total	39%	16%

In addition, even when elementary schools have the same number of computers as secondary schools, they tend to place their computers in more locations. For example, elementary schools with 10 to 14 computers divide their computers among 50% more locations than do middle or high schools with the same number of computers (a mean of 4.0 locations per school vs. 2.7 for secondary schools). Elementary schools that keep their computers in one or two locations use them roughly 10% more than do those that spread them among more locations.

Table 5: Computers in Classrooms by Grade Span of School, Spring, 1985.

Grade Span of School	Percent of Schools* With Any Computers in Classrooms	Percent of All Instructional Computers that Are in Classrooms	Percent of Schools* With Computers in More than 3 Classrooms	Percent of Computer Classrooms With more than 3 Computers
K-6 Elem.	76%	40%	22%	10%
Middle/Jr.High	70%	27%	9%	27%
High School	82%	38%	12%	44%
K-8 Elem.	67%	38%	10%	13%
K-12 School	81%	47%	13%	20%
Jr./Sr. High	81%	37%	7%	39%
U.S. Total	75%	37%	15%	20%

*Schools using computers for instruction.

Where are computers housed in school buildings, and are computers used differently in different types of rooms?

Computers used for school instruction can be found in classrooms, laboratories, libraries, offices, and hallways. They can be fixed or on mobile carts, rotating among several rooms. Here we summarize data on the number of computers by the type of room in which each computer mainly resides. Data for classroom computers are in Table 5; data for computers in labs and libraries are in Table 6.

Most computer-using schools (75%) have at least one computer in one classroom. Only about 44% of computer-using schools have a computer laboratory. Yet more school computers are in laboratories (49%) than in classrooms (37%). That is because a classroom typically has only one to three computers, and usually only one or two classrooms in a building have computers. In contrast, the typical secondary school computer lab has 13 or 14 computers and the typical elementary school lab has 8 computers. Most schools that have computer labs have only one, but almost 25% of computer-using high schools have more than one laboratory.

A much smaller proportion of K-6 elementary schools have laboratories (30%) than do middle (62%) or high (69%) schools. Yet the proportion of elementary school computers that are in classrooms

Table 6: Computers in Computer Labs and Libraries by Grade Span of School, Spring, 1985.

Grade Span of School	Percent of Schools* With Any Computers in:		Percent of All Instructional Computers in:		Median Number of Computers in a:	
	Lab	Library	Lab	Library	Lab	Library**
K-6 Elem.	30%	31%	40%	13%	8	2
Middle/Jr.High	62%	32%	62%	6%	14	2
High School	69%	33%	51%	4%	13	2
K-8 Elem.	43%	17%	46%	9%	7	4
K-12 School	46%	14%	44%	3%	7	1
Jr./Sr. High	52%	32%	53%	5%	11	2
U.S. Total	44%	28%	49%	8%	10	2

*Schools using computers for instruction.

**Among libraries with at least one computer.

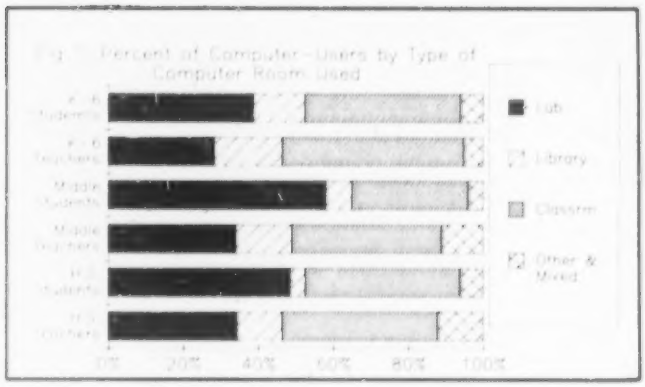
is roughly the same as the proportion of high school computers in classrooms (40% vs. 38%). Mainly this is because each elementary school classroom has so few computers. Of the elementary school classrooms with computers, 90% have three or fewer. In contrast, nearly half of the high school classrooms with computers have more than three. Also, libraries in elementary schools may act as "mini-labs." A higher proportion of elementary school computers are in libraries (13% in K-6 schools vs. 4% in high schools), although the typical elementary school library that has computers has only two of them.

Of all school levels, middle schools have the largest proportion of their computers located in laboratories. More than three-fifths of their computers are in labs, and their labs are just as large as those in high schools. Their greater clustering of computers extends to libraries as well. When middle schools put computers in libraries, typically they place four computers in them, twice as many as at other levels.

In most locations, only one or two teachers regularly use the computers in that room. In 60% of classrooms containing computers, only one teacher was reported to be a regular instructional user of the computers in that room. In about half of the laboratories where computers were used for instruction, only one or two teachers were regular users. However, elementary school computer labs and libraries are an exception to this pattern. In a K-6 school, the typical lab is used by six teachers and the typical library containing computers is used by four teachers.

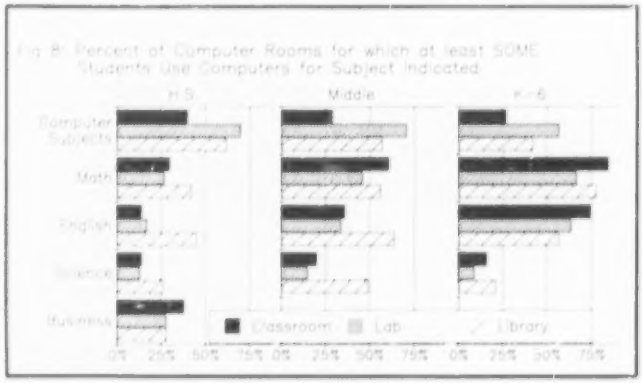
Overall, more computer-using teachers use computers in their own classroom than use them in laboratories, at all three levels of schooling. However, more middle and high school students use computers in lab settings than in classroom settings (Figure 7). Also, the proportion of students who use computers in library settings is much smaller than the proportion of teachers who do so. Thus, teachers tend to use library computers with only a few students.

At a given grade level, subject-matter uses of computers (such as for math, science or English instruction) are more likely than computer literacy or programming activities to occur in classrooms. Computer programming and computer literacy



activity occur mainly in computer labs. Roughly twice as many students study about computers or do programming in computer labs as do these things in classrooms, and at the middle school level the ratio is about 4-1.

However, programming activity is not the primary use of labs in elementary schools, where traditional subjects are the focus of most computer activity. Even in computer labs, more math and English instruction occurs than computer literacy and programming activity (Figure 8). Moreover, above the elementary school level, where laboratory use of computers is more widespread for all subjects, more math and English computer work is done in labs than in classrooms. Of the five high school curricular areas for which data was gathered, only business courses involve more computing activity in classrooms than in computer labs.



Library computers are used for a higher proportion of English (above elementary schools) and science (below high schools) computer work than for other subjects. But, overall, relatively few students at any grade level do their computer work in any subject on library computers.

Table 7: Student Use of Computers in Classrooms, Labs and Libraries by Grade Span of School, Spring, 1985.

Grade Span of School	Median Number of Student Users per Room with Computers			Median Hours of Use per Week Per Computer			Median Minutes per Week of Computer Use Per Student User		
	Class	Lab	Library	Class	Lab	Library	Class	Lab	Library
K-6 Elem.	27	150	50	15	20	15	27	48	24
Middle/Jr.High	30	112	30	15	25	20	28	92	55
High School	35	84	23	20	25	25	80	150	60

Do students get more time to use computers in laboratories?

Computer laboratories are used for more hours of the week than are classroom or library computers, especially in elementary and middle schools. In K-6 schools, laboratory computers are used for an average of 27% more time per week than are computers in either classrooms or libraries. (The means are 20.9 hours per week for labs, 16.4 for classrooms and 16.4 for libraries; the medians are 20 hours per week for labs, 15 hours for classrooms and 15 for libraries.) In middle schools, laboratory computers are used for 25% more time than are those in classrooms (the medians are 25 hours vs. 15 hours per week) and for 10% more time than are library computers.

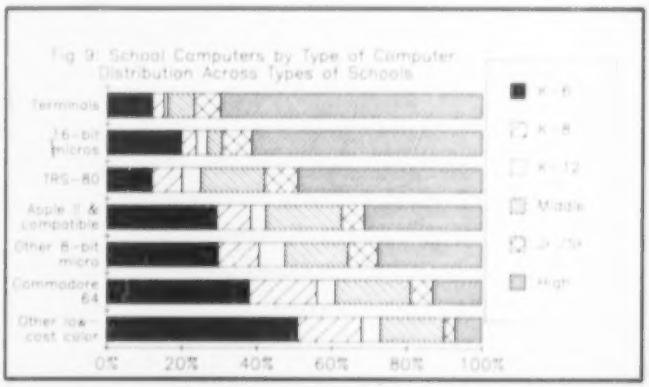
At the high school level, total time of use per computer is roughly the same in labs, libraries, and classrooms. However, the median lab computer is used for 5 hours more per week than the median classroom computer. Table 7 presents medians for a number of dimensions of computer use, including "weekly hours of use per computer," according to the type of room in which the computer is located and the grade span of the school.

The typical student working in a computer laboratory uses computers for about twice as much time as the typical computer user in a classroom. At the middle school level, the difference is 3 to 1. (See Table 7.) This is partly because students doing programming use more computer time than students doing C.A.I., and lab locations and programming tend to be associated. However, even holding constant the subject-matter for which computers are used, students using computers in laboratories appear to have as much as one-third more computer time than students using computers in classrooms. (This conclusion is imprecise, though, because these data were collected on how computers in each room were used rather than how each student used computers.)

What kinds of computers are in which levels of schools?

What schools can do with computers is constrained by the models of computers that they have, and the software and instructional materials available for those models. (Of course, schools choose particular models, in part, because of the curricular plans they have for them, so causality goes both ways.) Rather than categorize schools by the brand names of their computers, we have clustered computers on the basis of the kinds of activities which they and the software available for them make possible.

Figure 9 shows how several categories of computers are distributed across schools of various grade spans. (Although brand names appear in the



figure, the categories go across commercial brands. For example, Apple III and Commodore CBM are grouped with "other 8-bit micros" rather than with the Apple II and Commodore 64, respectively, and the Radio Shack Color Computer is grouped with "other low-priced color computers" rather than with the TRS-80 series.) The figure shows that most types of computers are confined primarily to either upper- or lower-grade level students. High schools and junior-senior highs together have 58% of the TRS-80 (models I, III, and 4), 70% of the 16-bit computers, and 76% of the mini- and mainframe terminals. In contrast, 56% of the Commodore 64's and 68% of the other low-priced color computers are found at elementary schools. Apple II-compatible computers are spread throughout elementary and secondary schools, constituting between one-half and three-fifths of the computers used in each of the six groups of schools in the figure.

HOW THE STUDY WAS CONDUCTED

The Sample

The schools selected for this survey are a stratified probability sample of 2,361 U.S. public and non-public elementary and secondary schools. (The sample did not include pre-primary schools or continuation high schools.) The sampling frame used for the study was the universe file of 100,625 schools belonging to Quality Education Data (QED), of Denver, Colorado. In order to provide the most detail possible about schools making varied and extensive uses of computers, schools with higher grade levels and schools expected to have more computers were oversampled. The sample includes 723 "K-6" schools, 251 "K-8" schools, 374 middle and junior high schools, and 1,013 schools enrolling high school students (some also containing younger students such as in K-12 and 7-12 multi-level schools). All analyses use a "reweighting" of the raw results so that the reported results may be interpreted as coming from a representative sample of all schools in the United States.

Source of The Survey Information

Information about how computers are used in schools was supplied by principals and computer-using teachers. The principal supplied 12 pages of background data as well as basic information about each computer-using teacher (up to 12) on a "Table of Computer-Using Teachers." A second survey booklet was completed by the person identified by the principal as the teacher or staff member most knowledgeable about how the school's computers were used. This "Primary Computer-Using Teacher" (PCUT) questionnaire was an 18-page booklet that requested extensive information about computer use in the school.

Also, up to four other computer-using teachers and administrators provided detailed information about instructional uses of computers in the classes that they taught. Each "User" completed one of seven different 14-page booklets tailored to the subject-matter for which that teacher used computers. Where the school had more than four "Users," computer-using teachers were sampled with varying probabilities in order to obtain the broadest range of school subjects and instructional applications possible (again, with data reweighted for analysis). Finally, in some schools a "non-computer using teacher" gave us attitudinal and teaching practice data that could be compared with the information given by the computer-using teacher at the same school.

Response Rates

Information about whether or not students at the school used computers was obtained for all but 14 schools. Of the 2,146 schools where students did use computers, the "Table of Computer-Using Teachers" was completed (either by mail or by telephone follow-up) for 2,101 schools (98%). The "Primary Computer-Using Teacher" questionnaire was completed by mail at 69% of the schools, and a subset of this instrument (approximately one-third of the questions) was completed by telephone for most remaining schools, bringing the overall response rate up to 92%. "User" questionnaries were completed by mail at a slightly lower rate than for "PCUTs" (about 60%), but telephone calls to a 1/5 subsample of non-respondents brought the effective response rate for teacher-users to 88% for those questions included in the telephone interview. 69% of the principals' own questionnaires were completed by mail, and the effective response rate for this instrument, including telephone follow-up subsampling, was 97%.

SPONSORSHIP AND ENDORSEMENT

The data were collected through funds provided by the National Center for Education Statistics and the National Institute of Education. The survey was endorsed by eleven major education and computer-related national associations: the National Association of Elementary School Principals, the National Association of Secondary School Principals, the National Education Association, the American Federation of Teachers, the National Catholic Educational Association, the American Association of School Administrators, the National Council of Teachers of Mathematics, the American Association of School Librarians, the International Council for Computers in Education, the Association for the Development of Computer-based Instructional Systems, and the Association for Educational Data Systems.

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